

# Miniature Biometric Sensor Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)



## ABSTRACT

Heart rate monitoring (HRM) is a critical need during exploration missions. Unlike the four separate systems used on ISS today, the single HRM system should perform as a diagnostic tool, perform well during exercise or high level activity, and be suitable for use during EVA. Currently available HRM technologies are dependent on uninterrupted contact with the skin and are prone to data drop-out and motion artifact when worn in the spacesuit or during exercise. Here, we seek an alternative to the chest strap and electrode based sensors currently in use on ISS today. This project aims to develop a single, high performance, robust biosensor with focused efforts on improved heart rate data quality collection during high intensity activity such as exercise or EVA.

## ANTICIPATED BENEFITS

### To NASA funded missions:

Heart rate monitoring is a medical requirement during ISS exercise, fitness tests, and extravehicular activity (EVA); however, NASA does not currently have the technology to consistently and accurately monitor heart rate and other physiological data during ISS daily exercise sessions or EVA's. In general, autonomous biometric feedback is limited during in-flight activity due to the lack of non-invasive instrumentation. The proposed ear bud based biosensor offers an innovative alternative to skin-mounted sensor for recording heart rate and provides additional biometric feedback such as core temperature and blood oxygen saturation monitoring. Providing the crew with visual feedback based on the proposed health risk assessment algorithm will advance the goals of autonomous crew health care needed for exploration missions.

### To NASA unfunded & planned missions:

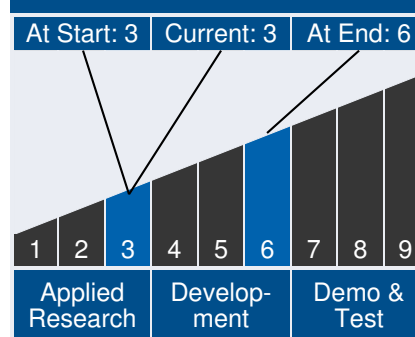


The miniature biosensor will provide valuable biometric feedback to astronauts working on Mars.

## Table of Contents

Abstract . . . . .	1
Anticipated Benefits . . . . .	1
Technology Maturity . . . . .	1
Detailed Description . . . . .	2
Management Team . . . . .	2
Technology Areas . . . . .	2
U.S. Locations Working on this Project . . . . .	3
Details for Technology 1 . . . . .	4

## Technology Maturity



# Miniature Biometric Sensor Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)



This technology will increase readiness for future exploration missions that require medical monitoring. The proposed ear bud based biosensor offers an innovative alternative to skin-mounted sensor for recording heart rate and provides additional biometric feedback such as core temperature and actigraphy.

## To other government agencies:

The proposed technology has potential for use by military personal to help track biometrics during training or while carrying out missions.

## To the commercial space industry:

The commercial space industry is preparing to support human spaceflight. Human health monitoring will be necessary at some level, and physiological parameters such as heart rate and temperature will continue to be of primary interest to those responsible for medical monitoring of commercial crews.

## To the nation:

Upon successful demonstration and commercialization of the miniature biosensor, the unit could be marketed to athletes, military, emergency medicine personnel, and remote health care providers. Additional telemedicine applications could be supported.

## DETAILED DESCRIPTION

Heart rate monitoring is a medical requirement during ISS exercise, fitness tests, and extravehicular activity (EVA); however, NASA does not currently have the technology to consistently and accurately monitor heart rate and other physiological data during ISS daily exercise sessions or EVA's. In general, autonomous biometric feedback is limited during in-flight activity due to the lack of non-invasive instrumentation.

A prototype ear bud based device that overcomes the data

## Management Team

### Program Director:

- John Falker

### Program Executive:

- Douglas Terrier

### Program Manager:

- Ronald Clayton

### Project Manager:

- Andrea Hanson

### Principal Investigator:

- Andrea Hanson

### Co-Investigators:

- Tommy Cooper
- Meghan Downs
- Stephanie Flint
- Baraquiel Reyna
- Cory Simon
- Grier Wilt

## Technology Areas

### Other Technology Areas:

- Human Health, Life Support & Habitation Systems (TA 6)
- Human Health & Performance (TA 6.3)
- Medical Diagnosis / Prognosis (TA 6.3.1)
- Long-Duration Health (TA 6.3.2)

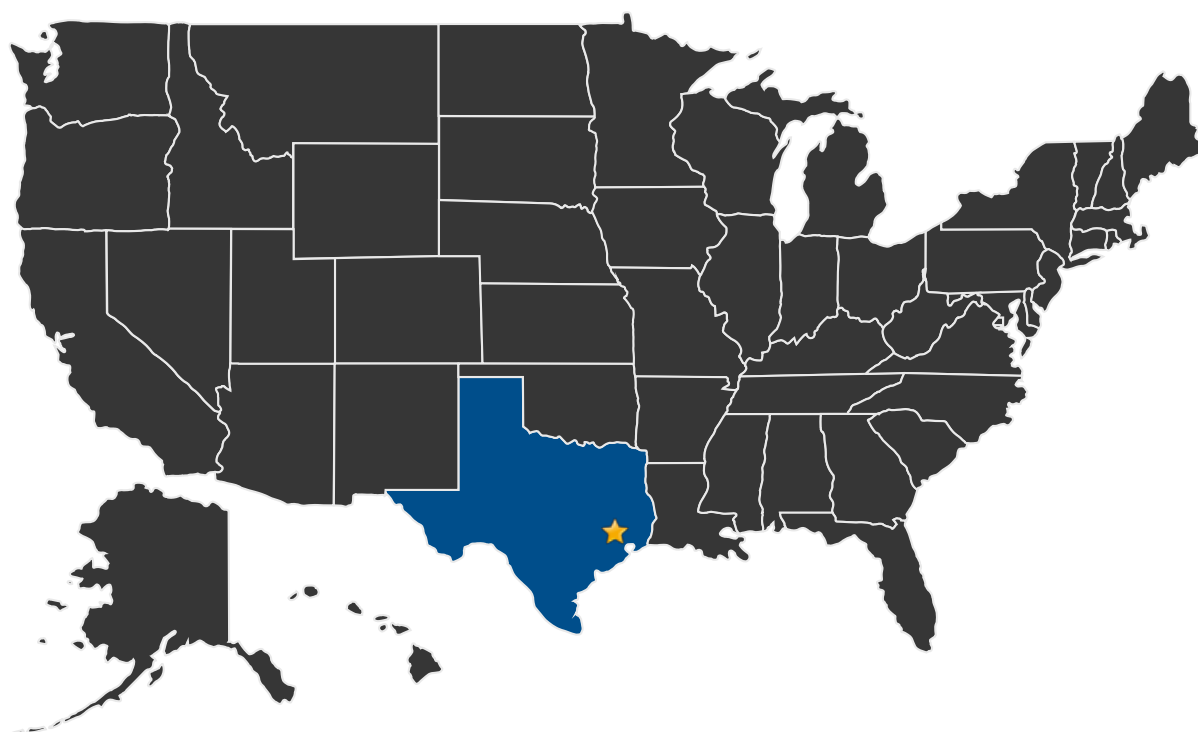
## Miniature Biometric Sensor Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)



interferences associated with skin mounted sensors has been proposed by our industry partner, Cooper Consulting Services (CCS). The proposed ear bud based biometric sensor offers an innovative alternative to skin-mounted sensor for recording heart rate and provides additional biometric feedback (core temperature and actigraphy) that is not available today. The architecture for a health risk assessment algorithm will be developed within the scope of this project. Providing the crew with visual feedback based on the algorithm would help to advance the goals of autonomous crew health care needed for exploration missions.

### U.S. LOCATIONS WORKING ON THIS PROJECT



■ U.S. States With Work

★ **Lead Center:**  
Johnson Space Center

#### Other Organizations Performing Work:

- Cooper Consulting Service

# Miniature Biometric Sensor Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)



## DETAILS FOR TECHNOLOGY 1

---

### Technology Title

Miniature Biometric Sensor

### Technology Description

This technology is categorized as a hardware assembly for wearable applications

The primary objectives of this project are, 1) To complete design and test of an ear bud based biosensor that will log biometric data, transmit the data wirelessly to a local computer, and provide real-time feedback; and 2) To develop the architecture for a health risk assessment algorithm that could be used in a visual display back to the user, using data from the biometric sensor. This work will advance the device from a TRL 3 to a TRL 6.

The requirements for device ruggedization will be developed. The prototype device will be tested in mission relevant activity at JSC facilities, which may include the Exercise Physiology and Countermeasures Laboratory or during suited activity. The device will also be tested during long duration use (>4 hours) in sleep and wake cycles. The team will work closely with the exploration medical capabilities team to build the technology from the start to allow for easy integration into a more comprehensive medical care system. The health risk assessment algorithm will be evaluated by human factors personnel to determine effectiveness of the visualization. Upon successful completion of this project, a second proposal will be submitted which will allow development of a more user friendly housing and flight certification for a technology demonstration on ISS.

### Capabilities Provided

The proposed biometric sensor and health risk assessment algorithm will provide a suite of physiological monitoring sensors in a compact, lightweight device that can be readily integrated into a more comprehensive medical kit, helping to meet the monitoring needs, and reduced mass and volume availability as estimated by the Integration Medical Model (IMM) for exploration missions of any duration. The capabilities of the proposed biosensor is also applicable to the NASA Technology Area Roadmap and specifically aligns with the following Technology Area Breakdowns Structures:

- TA06 - Human Health, Life Support, and Habitation Systems: Human Health and Performance -Medical Diagnosis/Prognosis and Long-Duration Health.

## Miniature Biometric Sensor Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)



### Potential Applications

Wearable technologies is an exploding field and presents a lucrative opportunity for commercialization to multiple end users. Upon successful demonstration of the biometric sensor, outcomes of this project may include 1) Advancement of a standalone biosensor product that will provide high quality heart rate data, core temperature, and actigraphy monitoring capabilities; and 2) Provide a robust and comprehensive biometric sensor with potential for commercialization to meet multiple population needs (ISS HR monitoring, athletes, military, emergency response personnel, and home health care providers). The benefit of adding a blood oxygen saturation sensor will also be evaluated.

Cooper Consulting Service (CCS) demonstrates agile engineering practices through focused product development, working knowledge of FDA and international standardization. CCS has brought many medical devices to commercialization and may opt to commercialize the ear bud biosensor product and market the device.

### Performance Metrics

Metric	Unit	Quantity
Heart Rate in Beats per Minute	bpm	Variable
Temperature in Degrees (Fahrenheit)	Deg	Variable